Toulouse, 24th June, 1999

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SSALTO

LEVEL 1.0 DORIS TIME-TAG DATA PROCESSING DEFINITION

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Document ref:	SMM-ST-M-EA-11443-CN		Issue: 0	Update: 2

For application	DS2	DS4	DS5	DH2	DPP	DJ1	TP	TP2	F-PAC	DOR	AVI	SOL
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Configuration controlled Document	YES	by: CCM SSALTO	Since: Nov. 13th, 98

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: i

Title: Level 1.0 DORIS time-tag data processing definition

TYPING FACILITIES

Original typing	Storage	Softwares
EUROSAV	t:\docenlign\smm\m\11443000.doc	Office 97

DOCUMENT STATUS

Page	i	ii	iii	iv	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Issue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Update	2	2	2	0	2	2	0	0	2	2	2	0	0	0	0	2	0	0

Page	15	16	17															
Issue	0	0	0															
Update	2	2	2															

DOCUMENT CHANGE RECORD

Is.	Up.	Date	Modifications	Visa
0	0	28th August 1998	Document creation	
0	1	28th April 1999	DM DPP-169-CN	
0	2	24th June 1999	DM SMM-M-38-CN	

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: ii

Title: Level 1.0 DORIS time-tag data processing definition

ABBREVIATIONS

Sigle	Definition
ADA	Algorithms Definition and Accuracy
ADx	Applicable Document x
APID	Application Process Identifier
CCI	Centre de Contrôle Instruments
CLS	Collecte Localisation Satellites
CMA	Centre Multi-missions Altimètre
CNES	Centre National d'Etudes Spatiales
DAD	Dynamic Auxiliary Data
DIODE	Détermination Immédiate d'Orbite par DORIS Embarqué (Navigator)
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
ET	Earth Terminal
FOCC	Flight Operation and Control Center
GPS	Global Positioning System
HKTM	HouseKeeping TeleMetry
TAI	International Atomic Time
ICU	Interface Control Unit
IGDR	Interim Geophysical Data Record
JCCC	Jason Control and Command Center
JPL	Jet Propulsion Laboratory
JSDS	Jason Science Data System
JTCCS	Jason Telemetry Command and Control System
LBR	Low Bit Rate
NASA	National Aeronautics and Space Agency
NRT	Near Real Time
OFL	Off-Line
PDS	Payload Data Segment
PF	Platform
PLTM	PayLoad TeleMetry
POS2	POSEIDON 2
RDx	Reference Document x
SAD	Static Auxiliary Data
SGDR	Sensor Geophysical Data Record
SSALTO	Segment Sol Altimétrie, Orbitographie et Localisation Précise
TBC	To Be Confirmed
TBD	To Be Defined
TM	Telemetry
TRSR	Turbo Rogue Space Receiver
USO	Ultra-Stable Oscillator
UTC	Universal Time Co-ordinated

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: iii

Title: Level 1.0 DORIS time-tag data processing definition

APPLICABLE AND REFERENCE DOCUMENTS

Reference		Document title
SMM-ST-M-EA-10600-CN	AD1	Spécifications techniques de besoins du Segment Sol Multi-Missions SSALTO
TP2-SB-J0-100-CNES	AD2	JASON System Requirements
TP2-JS-IF-600-CNES	AD3	Jason Ground System Interfaces
SMM-St-M-EA-11441-CN	AD4	POS2 level 1.0 Processing Definition
SMM-ST-M-EA-11454-CN	AD5	Spécifications techniques du traitement sol des télémesures DORIS.
DPP-CI-S/FOCC-EA-10028-ESA	AD6	DORIS/ENVISAT-1 CTDP/FOCC Interface Control Document
PRO-LS-DC-10090-CNES	AD7	PGGS Internal and External Interfaces Specifications.
DPP-CI-052/S-EA-10246-ESA	AD8	DORIS/ENVISAT-1 CTDP/PDS Interface Control Document
In progress	AD9	Spécifications des interfaces internes CCI
SMM-IF-M-EA-20054-CN	AD10	Catalogue des interfaces SSALTO
SMM-IF-M-EA-20055-CN	AD11	Dossier de spécifications des interfaces internes SSALTO
SMM-ST-M2-EA-10880-CN	RD1	Algorithm Definition and Accuracy Volume 2: CMA Altimeter Level 1b Processing
SMM-ST-M2-EA-10882-CN	RD2	Algorithm Definition and Accuracy Volume 4: CMA Altimeter Level 2 Processing
DPP-IF-D1/S-EA-10-CN	RD3	Spécification d'interface entre le segment sol DORIS/POSEIDON et l'instrument DORIS/ENVISAT
DJ1-IF-D1/M-EA-590-CN	RD4	Spécification d'interface entre le segment sol DORIS/POSEIDON (SSALTO) et l'instrument DORIS/JASON

TBC AND TBD LIST

TBC/TBD	Paragraph	Brief description
		None

	SSALTO	**Reference project:**	**SMM-ST-M-EA-11443-CN**
		Issue N°: 0	**Update N°: 2**
	PROJECT	**Date: 24th June 1999**	**Page: iv**

Title: Level 1.0 DORIS time-tag data processing definition

CONTENTS

		Reference project:	**SMM-ST-M-EA-11443-CN**
	SSALTO	**Issue N°: 0**	**Update N°: 2**
	PROJECT	**Date: 24th June 1999**	**Page: 1**

Title: Level 1.0 DORIS time-tag data processing definition

1. INTRODUCTION

1.1. PURPOSE

This document is aimed at defining the level 1.0 DORIS Time-Tag data processing of the DORIS Instrument.

For the second generation of the instrument (on board ENVISAT and JASON), DORIS is able to time-tag a pulse generated by the platform, in CNES Julian Day. Data collected by the platform are called TAI DORIS Time-Tags. The raw DORIS time-tag data are downlinked at each satellite visibility and encapsulated in a level 0 format by the satellites ground systems.

This document describes the requirements of the processing to get level 1.0 TAI DORIS Time-Tag from level 0 data. The output of this processing, level 1.0 DORIS Time-Tags, is used in:

- the conversion in TAI of JASON POS2 data,
- the monitoring of DORIS performed by CCI in SSALTO.

The main steps identified in the TAI DORIS Time-Tag processing are:

- the extraction of raw time-tag measurement from level 0 PLTM packets of JASON or from HK TM product from FOCC for ENVISAT,
- the generation of the level 1.0 DORIS Time-Tag Product.

These processing steps shall be implemented in each Ground Segment for ENVISAT and JASON, and so in:

- SSALTO for JASON and ENVISAT processings,
- JSDS, the JPL mission center which produces the JASON NRT products during the routine phase (see AD2 and AD3.

This document is aimed at identifying and describing the main functions of each processing step. It must be considered as the basic input for the detailed requirements of the processing, and not of course as the detailed requirements themselves.

Reception of level 0 data is not detailed here because this function is specific to JSDS or to SSALTO (described in AD5 for SSALTO). The monitoring of DORIS deduced from the navigation data is only performed in SSALTO and is described in AD5.

		Reference project:	SMM-ST-M-EA-11443-CN
	SSALTO	Issue N°: 0	Update N°: 2
	PROJECT	Date: 24th June 1999	Page: 2

Title: Level 1.0 DORIS time-tag data processing definition

1.2. ORGANISATION OF THE DOCUMENT

The product tree (see **Figure 1** below) points out the main features of the level 1.0 TAI DORIS Time-Tag processing (grey cells) and of the corresponding output data (white cells are interfaces).

The interfaces of the processings (input and output data) are defined in section 2.

Extraction of raw time-tag measurement is defined in section 3.

Generation of the level 1.0 Time-Tag Product is defined in section 4.

For each processing, the definition consists of:

- An overview of the overall processing (brief description of the processing and list of functions). Be aware that functions which proceed with data management or quality check, such as for example:

    - To get and prepare input data from disk space,
    - To check input data,
    - To convert units,
    - To manage the processing,

    are generally not detailed in this document, because they are not considered as critical items in the framework of the present processing definition. They will be represented and described more accurately in another document during the processing detailed requirements phase.

- A detailed description of all the functions. For each function, the following items are used:

    - Name,
    - Function description,
    - Applicability,
    - Input data:

        - Product data: data coming from the telemetry
        - Computed data: data issued from a previous algorithm
        - Dynamic auxiliary data: time-varying auxiliary data
        - Static auxiliary data: constant auxiliary data

    - Output data,
    - Statement,
    - Accuracy (if any)
    - Comments (if any)

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 3

Title: Level 1.0 DORIS time-tag data processing definition
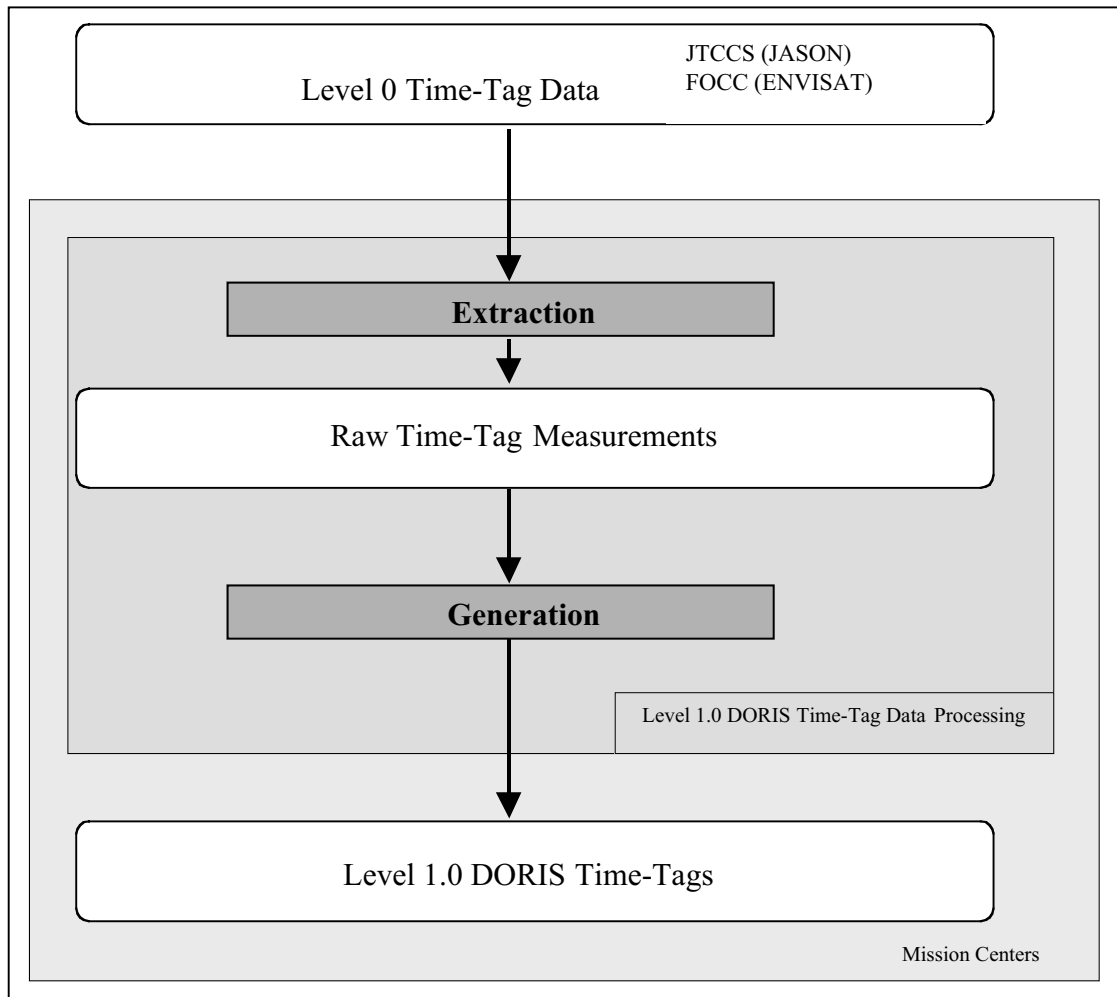
- References (if any)

Figure 1: Product tree (Level 1.0 DORIS Time-Tag data processing)

1.3. SCOPE

All the functions of the Level 1.0 DORIS Time-Tag processing are applicable to the CNES mission Center (SSALTO) and to the JPL mission Center (JSDS).

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 4

Title: Level 1.0 DORIS time-tag data processing definition

2. INPUT AND OUTPUT DATA

Inputs and outputs exchanged between sub-systems of the french mission center SSALTO, are described in AD10 and AD11.

Specific inputs or outputs used during the level 1.0 time-tag data processing are described in AD9, to be written during the detailed requirements phase.

2.1. INPUT DATA

Two types of input data may be discriminated:

- Level 0 Time-Tag Data source packets, which correspond to raw data produced by the DORIS instrument and encapsulated by ground segments;
- Auxiliary data, which may be dynamic or static:
    - Dynamic auxiliary data (DAD) are time-varying data,
    - Static auxiliary data (SAD) are constant data.

2.1.1. LEVEL 0 TIME-TAG DATA

Raw data are generated by DORIS each time a pulse to time-tag is received: twice an orbit for ENVISAT or once a second for JASON. They are delivered by the platform in frames or sources packets (see RD3 and RD4).

2.1.1.1. ENVISAT Level 0 Time-Tag Data

On the ENVISAT PF, Time-Tag Data are delivered in ICU HK frames. FOCC receives the ICUHK frames, which are delivered and processed by the FOCC to generate Housekeeping Telemetry Data.

For the description of the level 0 time-tag data in the Housekeeping Telemetry from FOCC see AD6 and AD5, and RD3.

2.1.1.2. JASON Level 0 Time-Tag Data

One Earth Terminal of the Jason ET Network (see AD2) receives a set of APID as PLTM frames during the satellite visibility. This set of frames is called a segment of data and is sent to JTCCS. Then, JTCCS processes these frames into JTCCS packets (see AD3) for each APID.

For our purpose, these APID are gathered in two main sets:

- the Operational Science Data (including the Time-Tag Data)
- the Raw Science Data whose priority is lower in terms of downlink operations, since Operational Science Data is used for NRT processing.

	SSALTO **PROJECT**	**Reference project:**	**SMM-ST-M-EA-11443-CN**
		Issue N°: 0	**Update N°: 2**
		Date: 24th June 1999	**Page: 5**

Title: Level 1.0 DORIS time-tag data processing definition

The Operational Science Data is composed of (see AD2):

- Level 0 Navigation Data Source Packets,
- Level 0 Time-Tag Data processed by DORIS,
- Level 0 POS2 source packets for NRT processing,
- Level 0 JMR source packets.

The Raw Science Data is composed of set of science source packets from DORIS and POS2 and TRSR. Processing of these raw science data is described in AD4 for POS2, in AD5 for DORIS. They are independent of Level 1.0 time-tag data processing.

For the description of the level 0 time-tag data from the JTCCS, see AD3 and AD7, and RD4.

2.1.2. AUXILIARY DATA

- **Dynamic auxiliary data:**

Specific dynamic auxiliary data consist of the last time-tag of previous processed data (used to detect lack of telemetry), defined in AD9.

- **Static auxiliary data:**

Static auxiliary data consist of constant processing parameters such as:

- Thresholds to check quality, defined in AD9,
- UTC-TAI Differences, defined in AD11,
- polynomial transfer functions, defined in AD9,
- decommutation tables described in the Satellite Database from JCCC (see AD3) or the FOCC (see AD6) and defined in AD9.

2.2. OUTPUT DATA

2.2.1. LIST OF OUTPUTS

The output is the Level 1.0 Time-Tags product generated at each acquisition of source packets.

A report file, as defined in AD9, contains:

- statistics: number of valid data, number of error data, number of redundant data, etc.
- product characteristics: mission id, data time window, etc.

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 6

Title: Level 1.0 DORIS time-tag data processing definition

2.2.2. MAIN CHARACTERITICS OF LEVEL 1.0 TIME-TAG DATA PRODUCT

Level 1.0 Time-Tag data product is an input of the generation of JASON POS2 Level 1.0 Processing. For DORIS/ENVISAT, it is not used operationaly for altimetry but is only used for investigations.

- This output is a level 1.0 product and therefore:

- corresponds to a segment of data without redundant information,

- is chronologically ordered,

- data are in physical values,

- TAI time is used,

- All parameters have been checked and quality flags are set.

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 7

Title: Level 1.0 DORIS time-tag data processing definition

2.3. SUMMARY OF THE INTERFACES

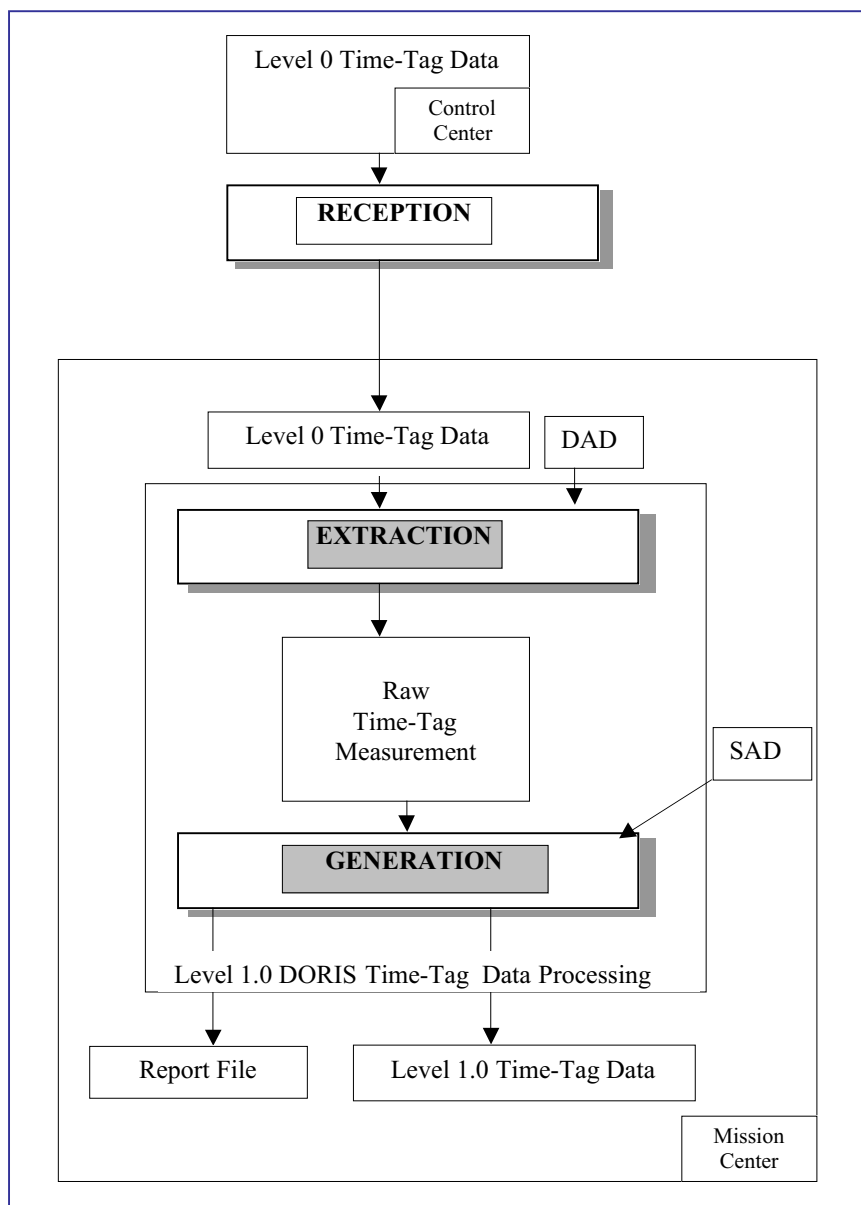The interfaces of the TAI DORIS Time-Tag processing are summed up in **Figure 2**.

Figure 2: Interfaces of Level 1.0 DORIS Time-Tag data processing

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 8

Title: Level 1.0 DORIS time-tag data processing definition

3. "EXTRACTION" PROCESSING

The goal of this processing is to extract the raw time-tag measurements from the level 0 time-tag data, i.e. to transform level 0 time-tag data whose format is specific to each satellite ground system into a common raw time-tag measurement SSALTO format, whatever the satellite.

3.1. PROCESSING OVERVIEW

3.1.1. BRIEF DESCRIPTION

Once data are collected by the Reception processing, the Extraction processing extracts raw time-tag measurements from level 0 time-tag data source packets and removes extra information added by the satellite ground systems.

The Extraction processing has to detect lacks of TM. The relevant time information used to perform this monitoring is the platform time, i.e. GPS-UTC creation time, given in the JTCCS PLTM packets for JASON, and on-board time, converted in UTC by FOCC for ENVISAT.

For Jason, data are chronologically ordered in each JTCCS PLTM packet due to the protocol of exchange between the instruments and the satellite platform. Moreover, there is no overlap between data segments thanks to the organisation of the dump of the platform memory. If JTCCS detects a lack of telemetry after a downlink, then telemetry is not delivered to the others components of the Jason ground segment. A second dump of the PF memory is performed and checked before delivery of the whole downlinked telemetry.

For ENVISAT, raw data are collected by the Interface Control Unit and delivered to the platform in HK source packets. ICU and PF are synchronised so as to get complete raw data. There is no overlap between telemetry records. The Generation processing deletes redundant information.

Thus, the Extraction processing does not check chronology of level 0 time-tag data and instrument time-tag. It processes data in the same order as their reception.

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 9

Title: Level 1.0 DORIS time-tag data processing definition

3.1.2. LIST OF FUNCTIONS

The list of the functions of the Extraction processing is given in **Figure 3**.

FUNCTION
TO DETECT LACKS OF TELEMETRY
TO EXTRACT RAW TIME-TAG MEASUREMENT FROM SATELLITE GROUND SYSTEM SOURCE PACKETS

Figure 3: Functions of the Extraction processing

3.2. FUNCTIONS

A detailed description of the functions of the Extraction processing is given in this section.

3.2.1. TO DETECT LACKS OF TELEMETRY

Function

This function detects lacks of telemetry by checking the on-board time UTC time of data sources packets given by the satellite ground segment.

Applicability

ENVISAT and JASON

Input data

- Product data:
  - current data source packet
  - previous data source packet
- Computed data: UTC GPS time tag of the last HK source packet
- Dynamic auxiliary data: None
- Static auxiliary data:
  - Extraction processing configuration file defining the acceptable telemetry time gap and the processing configuration.

Output data

- Continuity check status
- Duration gap

	SSALTO **PROJECT**	**Reference project:**	**SMM-ST-M-EA-11443-CN**
		Issue N°: 0	**Update N°: 2**
		Date: 24th June 1999	**Page: 10**

Title: Level 1.0 DORIS time-tag data processing definition

Statement

This function checks that there is no more than the acceptable duration lack between two raw data source packets (test of the UTC on-board time difference between the current packet and the previous packet, relative to the acceptable telemetry gap). If a continuity default is detected, this function returns a significant status of the continuity check and the value of the duration gap.

Accuracy: /

Comments: /

References: /

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 11

Title: Level 1.0 DORIS time-tag data processing definition

3.2.2. TO EXTRACT RAW TIME-TAG MEASUREMENT FROM SATELLITE GROUND SYSTEM SOURCE PACKETS

Function

This function extracts the instrument raw time-tag measurements (defined in RD3 and RD4) from the level 0 time-tag data source packets delivered by the satellite ground system (see AD6, AD7).

Applicability

ENVISAT and JASON

Input data

- Product data:
    - Satellite ground system source packets
- Computed data: None
- Dynamic auxiliary data: None
- Static auxiliary data: None

Output data

- Raw time-tag measurements (defined in AD9)

Statement

This function generates raw time-tag measurements from level 0 time-tag data source packets by removing the headers (and extra information for ENVISAT) described in the satellite/ground system interfaces.

Accuracy: /

Comments: There is only one raw time-tag measurement by level 0 time-tag data source packet.

References: /

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 12

Title: Level 1.0 DORIS time-tag data processing definition

4. "GENERATION " PROCESSING

4.1. PROCESSING OVERVIEW

A level 1.0 time-tag data product is generated from the extracted raw time-tag measurements for each data segment.

4.1.1. BRIEF DESCRIPTION

A brief overview of the main functions of the Generation processing is given in this section. A detailed description is provided in section 4.2.

The generation of level 1.0 Time-Tag data product uses many functions identical to or derived from functions already described in AD4 (function and statement parts):

- To extract a parameter,
- To apply a transfer function,
- To convert UTC Time in TAI.

The other function (To check for redundant/default information) is very similar to function of the "Level 1.0 Navigation data Processing".

The order of the description of the functions respects their chronology.

4.1.2. LIST OF FUNCTIONS

A list of the functions of the Generation of Level 1.0 DORIS Time-Tags processing is given in **Figure 4**.

FUNCTION
TO EXTRACT A PARAMETER
TO APPLY A TRANSFER FUNCTION
TO CONVERT UTC TIME IN TAI
TO CHECK FOR REDUNDANT/DEFAULT INFORMATION
TO CHECK UTC AND TAI TIME TAG

Figure 4: Functions of the DORIS Time-Tag Generation processing

		Reference project:	SMM-ST-M-EA-11443-CN
	SSALTO	**Issue N°: 0**	**Update N°: 2**
	PROJECT	**Date: 24th June 1999**	**Page: 13**

Title: Level 1.0 DORIS time-tag data processing definition

4.2. **FUNCTIONS**

A detailed description of the functions of the Level 1.0 DORIS Time-tag data Generation processing is given in this section.

4.2.1. TO EXTRACT A PARAMETER

Function

See AD4.

Applicability

ENVISAT and JASON

Input data

- Product data:
    - Raw Time Tag Measurement (see RD3 and RD4 for the content of source packets).
- Computed data: None
- Static auxiliary data: Decommutation tables.

Output data

- Raw parameter.

Statement

See AD4.

Accuracy   None

Comments   This function is called for all the parameters of raw time-tag measurement.

References   None

	SSALTO PROJECT	Reference project: SMM-ST-M-EA-11443-CN
		Issue N°: 0 Update N°: 2
		Date: 24th June 1999 Page: 14

Title: Level 1.0 DORIS time-tag data processing definition

4.2.2. TO APPLY A TRANSFER FUNCTION

Function

See AD4.

Applicability

ENVISAT and JASON

Input data

- Product data: None
- Computed data: Raw Parameter, output from "To Extract a Parameter".
- Static auxiliary data: polynomial transfer functions.

Output data

- Parameter in physical value.

Statement

See AD4.

Accuracy   None

Comments   This function is called for all the parameters of raw time-tag measurement.

References   None

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 15

Title: Level 1.0 DORIS time-tag data processing definition

4.2.3. TO CONVERT UTC TIME IN TAI

Function

See AD4

Applicability

ENVISAT and JASON

Input data

- Product data:
    - UTC on-board creation time of each raw time-tag measurement (see AD8, AD6, RD4).
- Computed data: None.
- Static auxiliary data: UTC/TAI time differences.

Output data

- TAI creation Time of each raw time-tag measurement.

Statement

Adds the appropriate UTC/TAI difference to convert the UTC creation time into the TAI creation Time.

Accuracy   None.

Comments   This function is called for each raw time-tag measurement.

For Jason , the UTC time is the time provided by the platform GPS.

For ENVISAT, the UTC time is the time derived by the ICU from the platform time

References   None

4.2.4. TO CHECK FOR REDUNDANT/DEFAULT INFORMATION

Function

This function detects and deletes redundant or default information in the raw time-tag measurement.

		Reference project:	SMM-ST-M-EA-11443-CN
	SSALTO	Issue N°: 0	Update N°: 2
	PROJECT	Date: 24th June 1999	Page: 16

Title: Level 1.0 DORIS time-tag data processing definition

Applicability

CNES and NASA

Input data

- Product data: Raw Time-Tag Measurement Data

- Computed data: None

- Static auxiliary data: None.

Output data

- On-Board DORIS Time-Tags.

Statement

For ENVISAT only, redundant data (different creation time and same DORIS TAI time TAG)are identified as "redundant" and deleted so as to keep the raw time-tag measurement whose creation time is the oldest.

For Jason only, if there are TAI time tag measurement with the same creation time and different DORIS TAI time tag parameters, then extrapolate the correct TAI creation time by adding the difference of the number of GPS pulse to the TAI plateforme creation time.

Non-significant Time-Tags Data (all fields equal to 0, or to 'FFFF'H in case of DORIS/ENVISAT instrument) are identified as "default" and are also deleted.

When selected, data is registered by creation time chronology.

Accuracy   None

Comments   The On-Board Time-Tag Measurements is the result of the four functions described above.

References   None

	SSALTO PROJECT	Reference project:	SMM-ST-M-EA-11443-CN
		Issue N°: 0	Update N°: 2
		Date: 24th June 1999	Page: 17

Title: Level 1.0 DORIS time-tag data processing definition

4.2.5. TO CHECK UTC AND TAI TIME-TAG

Function

This function checks the value of the Creation Time of the On-Board Time-Tag Measurement with the TAI Time delivered by DORIS.

Applicability

ENVISAT and JASON

Input data

- Product data: On-Board DORIS Time-Tags Measurements.
- Computed data: TAI creation time minus TAI time-tag.
- Static auxiliary data: Threshold.

Output data

Quality flag.

Level 1.0 Time-tag Data (see AD11).

Statement

This function checks the difference between the TAI creation time (computed from the UTC time delivered by the platform) and the TAI time delivered by DORIS within the on-board time-tag measurement. If its value exceeds a threshold (static but that may be changed), the quality flag is set to "non-valid", else to "valid".

A monitoring of the difference and of its evolution is performed and traced in the report file.

A report file reporting characteristics of the level 1.0 time-tag data product is generated.

Accuracy   None

Comments   None

References   None